COMPARISON OF TWO REMOTE SENSING TECHNIQUES (AERIAL AND TERRESTRIAL) WITH TRADITIONAL FIELD-BASED METHOD FOR FOREST INVENTORY

Del Perugia B.[1], Barzagli A. [1], Giannetti F. [1], Barbati A. [2], Lasserre B. [3], Chirici G. [1], Travaglini D.[1]

1. *Department of agricultural, food and forest ecosystems menagement (GESAAF), University of Florence, Firenze, Italy*
2. *Department of innovation in biological systems, food and forestry, University of Tuscia, Viterbo, Italy*
3. *Department of biosciences and Territory, University of Molise, Isernia, Italy*

INTRODUCTION

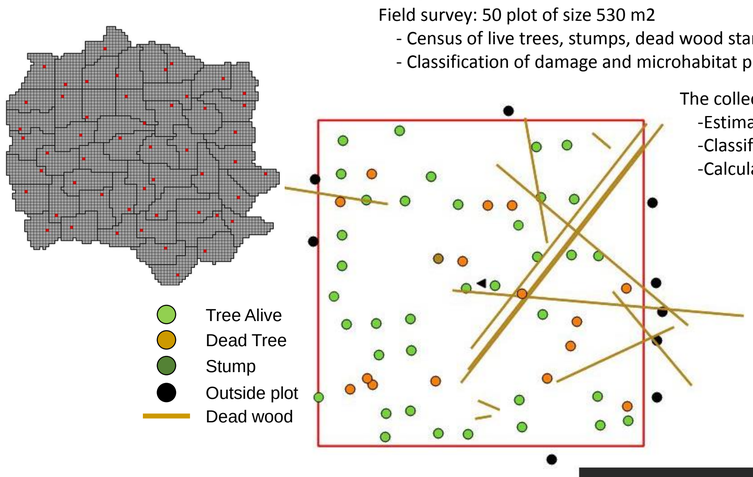
To effectively plan sustainable management of forest ecosystems detailed and up-to-date spatial information are needed. Remote sensing platforms equipped with multispectral optical sensors and/or laser scanners allow capturing extremely useful data for the characterization of forest. Depending on the aim, scale, resources and the required accuracy, there are many kinds of forest inventory techniques that can be applied.
The object of this work is to compare the integrated use of inventory and of two remote sensing techniques (aerial and terrestrial) with traditional field-based methods to map forest types distribution, vegetation structure and estimation of Sustainable Forest Management (SFM) indicators .

The first case study, based on Airbone-Laser-Scannning data and RGB-images in Rincine Forest (FI) was conducted within the FRESh LIFE project (LIFE14 ENV/IT/000414), whose aim is to demonstrate the technical and economic feasibility of integrating data from forest inventories with information obtained from remote sensing, and to use this approach to develop SFM indicators to help forest managers evaluate sustainable forest management practices. With multispectral optical sensors and laser scanners mounted on SAPR and conventional systemse we mapped the forest variables useful to describe the qualitative and quantitative characteristics of forests on the operational scale of forest management.

Inventory Data

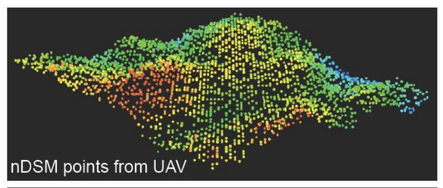
Study area: Rincine forest (FI), 270 ha
Sampling scheme: One-per-stratum stratified sampling, square areas of 23x23 m.
Field survey: 50 plot of size 530 m2
- Census of live trees, stumps, dead wood standing and on the ground
- Classification of damage and microhabitat presence

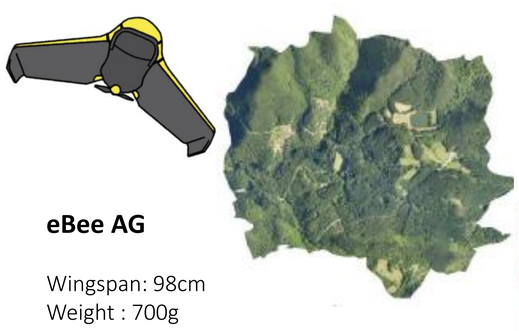
The collected data was used for:
-Estimation of volume (m3 / ha)
-Classification of forest types
-Calculation of SFM indicators



Remote sensing Data

Flight campaigns with two types of SAPR





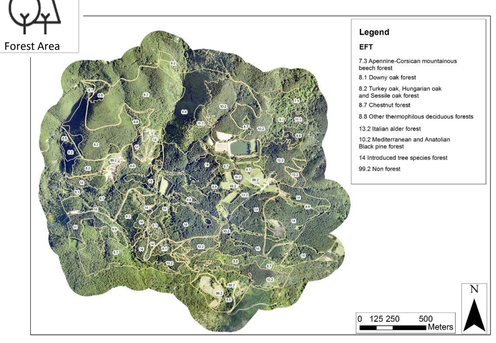
eBee AG

Wingspan: 98cm
Weight : 700g
Battery: 45min
Sensors: **RGB and NIR** up to 3 cm resolution

Octocopter

Diameter: 180cm
Weight : 15kg
Battery: 20min
Sensors: **LIDAR Yellohscan**
Up to 50 point/m^2

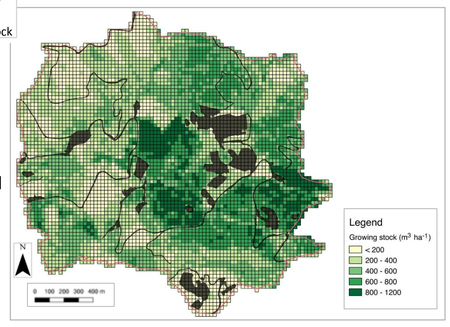
Forest Area



The study area has been classified into forest types according to the legend of the European Forest Type and the FAO-FRA forest definition (area min 0.5 ha).

Growing stock

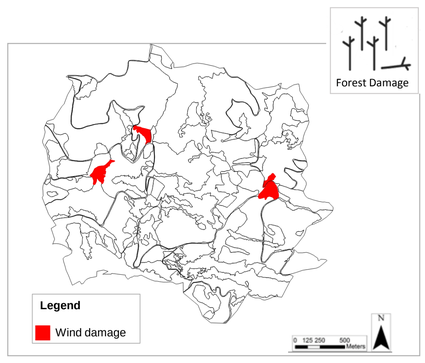
In order to estimate the volume per hectare (V, m3/ha), a linear regression model was constructed combining inventory data with remote sensing data.



The eBee's point cloud obtained with photogrammetric techniques was normalized with a DTM derived from LiDAR airplane; the data was processed to calculate the metrics to be used as predictor variables; the models were tested based on the volume measured in the plot.

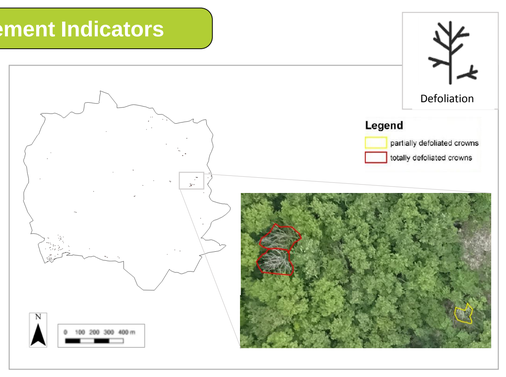
Mapping Sustainable Forest Management Indicators

Forest Damage



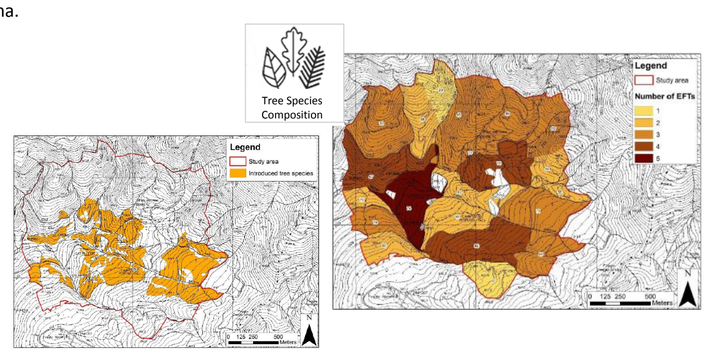
The forest damage map was produced by photo interpretation since a windstorm occurred in march 2015. Minimum mapping unit 0.25ha, total 3ha.

Defoliation



The defoliation map was produced by photo interpretation (min mapping unit ≥ 3m2), two classes were identified
1 = partially defoliated (more than 70%)
2 = completely defoliated (dead)

Tree Species Composition



The map of forest type was produced by photo interpretation of eBee's orthophotos. The result of the classifications was evaluated by comparison with the inventory plot. The overall accuracy of classifications was evaluated with 2 indexes: overall accuracy (OA) and kappa index of agreement (KIA).
A specific map for the introduced forest species (FIS) shows that 25% of the study area (70 ha ca) is cover with reforestation species, such as Douglas (*Pseudotsuga menziesii*).

For the second case study conducted in Amiata forest (SI) we used a Handheld Mobile Laser Scanning ZEB1. The aim was to obtain detailed information for the management and monitoring (precision forestry) of Chestnut forest. We assessed the potential of the HMLS for a detailed inventory of valuable forest areas, in particular for the parameters: Number of trees, position (x,y) of trees, DHB, heights, crown base heights and crown widths.

Inventory Data

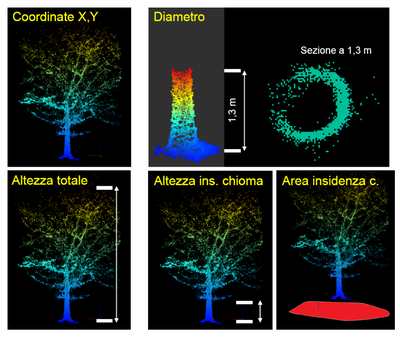
Study area: Amiata (SI)
Field survey: 3 plot (one size of 2827m2 and two size of 4410m2)
-Position of trees
-Dendrometric attributes of trees
-Classification chestnut variety, damage and thinning

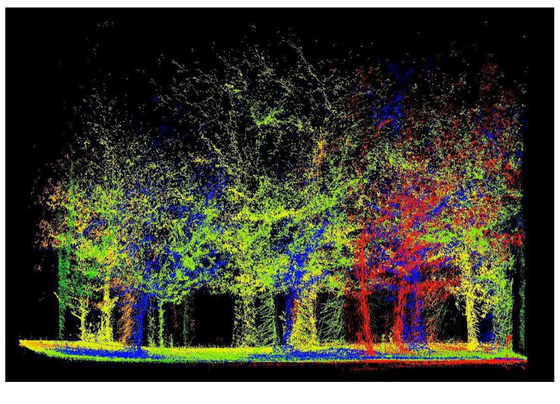
Remote sensing Data

ZEB1 is a 3D, time-of-flight laser with a frequency of 43,200 points/s and an horizontally field of view of 270° and approximately a vertically one of 120°.

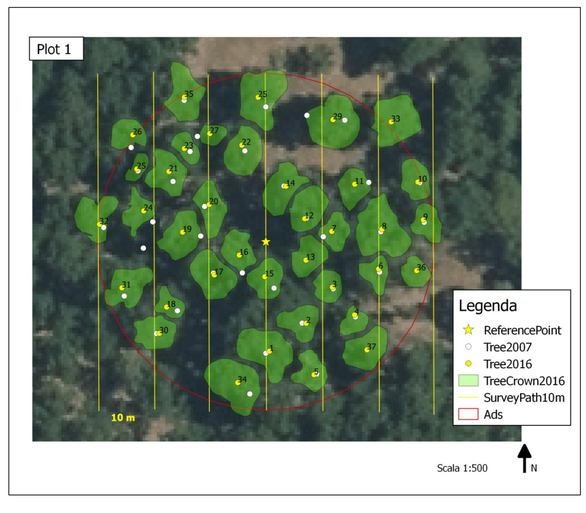
Method

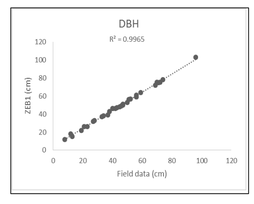
A linear path was designed for the surveys with a range of 10m. We positioned some "ground point" (white spheres mounted on poles) at fixed distances, as fixed point to locate the path to do; we also acquired the coordinates of one of this, coincident with the center point of the survey, with a GPS Trimble JUNO.

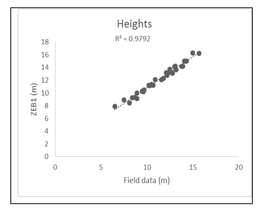


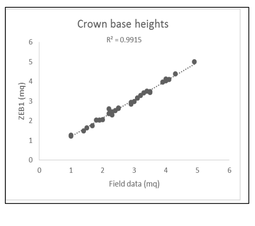


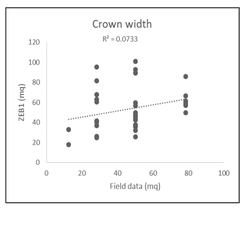
Results and Map











The number of tree censed in 2016 is 37 while in 2007 was 35, the difference positioning between the two method is 1,6m of average, with a max of 4,5m and a min of 0,3m.
The correlations for DBH, heights and crown base heights are very good R^2>0,9; unlike the crown width probably due to the 2007 census method, more imprecise for measuring crown width.